Program Progress Report
CDRL A002

Pilot-in-the-loop Method Development

2012 Basic and Applied Research in Sea-Based Aviation

ONR #BAA12-SN-0028

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PERIOD 20 June 2014 to 20 July 2014

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1 PROJECT OVERVIEW

The goal of this project is to integrate novel numerical modeling and computer hardware approaches to compute the non-linear aerodynamic coupling between the ship and aircraft in such a way that execution times are at real-time speeds, allowing for pilot-in-the-loop CFD to be integrated in the piloted flight simulation environment. To achieve the speed gains required, three areas will be targeted for implementation into the CFD simulation framework: (1) numerical algorithms, (2) novel domain boundaries, and (3) Graphical Processing Unit (GPU) hardware. A framework will be established to link the CFD with realtime simulations. A building block approach will be employed to first demonstrate non-realtime integration of the CFD simulation framework with helicopter flight dynamic models, then realtime execution for a minimum fidelity airwake/aircraft simulation, then build to higher fidelity realtime simulations.

1.1 Project Technical Objectives

The project involves the following seven tasks to accomplish the technical objectives of the project:

Task 1: Implement modular implicit/explicit solver

Task 2: Apply structured numerics

Task 3: Apply subdomain with immersed boundary

Task 4: Implement higher order explicit solver for GPU execution

Task 5: Integrate with the GENHEL-PSU flight dynamics model

Task 6: Demonstrate flight simulation in the PSU Rotorcraft Simulation Facility

Task 7: Demonstrate flight Simulation in NAVAIR Manned Flight Simulator

2 WORK SUMMARY

During this reporting period, structured simulations for the example LHD airwake were initiated using the improved incompressible formulation implemented in the CRAFT CFD solver that was presented in the previous report. The goal of these simulations is to provide a verification of the structured airwake solution against standard practice unstructured results for the ship platform of interest: LHD.

Figure 1 shows the structured grid created for the LHD geometry. Boundary layer spacing of the grid was the same as for the previous unstructured grid. A total grid size of about 14 million cells was achieved, close to the 10 million cell target determined in previous discussions.

Both structured and unstructured cases are in progress and results will be compared in a future report.

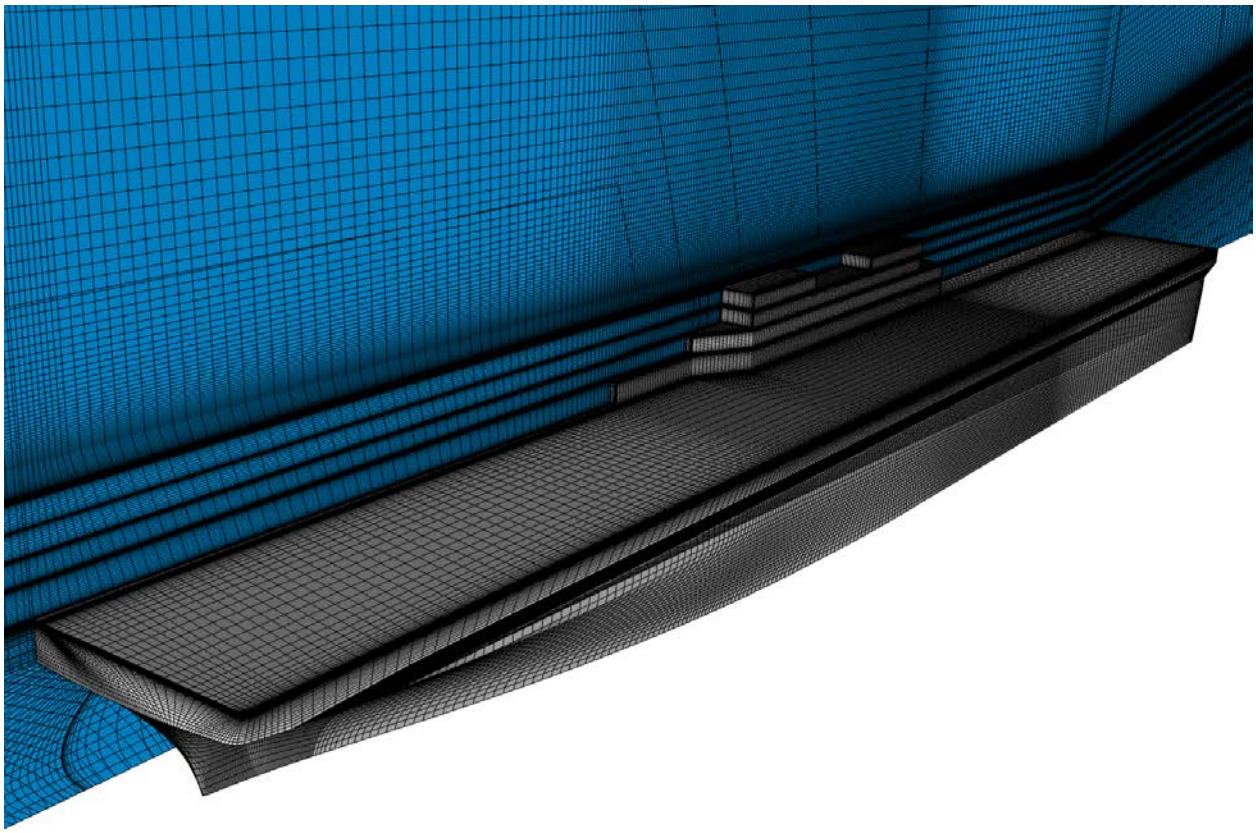

Figure 1: Structured grid for the LHD airwake simulation.

3 TECHNICAL/COST STATUS AND PROBLEM AREAS

No technical or financial problems have been encountered.

4 MEETING AND/OR TRAVEL

N/A

5 CONTRACT SCHEDULE

The program is proceeding as planned.

6 PLANNED ACTIVITIES FOR NEXT REPORTING PERIOD

Planned work for the next reporting period includes (1) completion of the LHD simulations and comparison of the results, and (2) collaboration with Penn State University on a coupling approach for fully coupled GENHEL/CRUNCH CFD simulations.

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